A statistical test of astrology

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This paper describes a recent test conducted in Maharashtra to test the predictive power of natal astrology. It involved collecting 200 birth details of 100 bright school students (group A) and 100 mentally retarded school students (group B). These details were used to cast horoscopes or birth charts for these children. After recording these details the charts were mixed and randomized and astrologers were invited to participate in a test of their predictive ability. Fifty-one astrologers participated in the test. Each participant was sent a random set of 40 birth charts and asked to identify to which group each chart corresponded. Among the initial 51 participants, 27 sent back their assessment. Statistical analysis of the results showed a success rate marginally less than what would be achieved by tossing a coin. The full sample of 200 birth charts was given to the representatives of an astrology institute for identification. They also did not fare any better. The limited but unambiguous procedure of this test leaves no doubt that astrology does not have any predictive power as far as academic ability is concerned. Ways of extending the scope of this test are discussed for future experiments.

In the popular mind astrology is often confused with astronomy. Since both subjects talk about stars, constellations, planets and the sun and the moon, it is usually assumed that both are branches of science dealing with the cosmos. An example of this was the announcement by the University Grants Commission in 2001, that a subject called 'Vedic astrology' should be introduced in the science stream of the university syllabus.

Is astrology a science? A closer examination suggests that the answer to this question is 'no'. A subject claiming to be part of science needs to satisfy certain minimum criteria. First, it should be based on postulates or assumptions that are clearly defined and are unique so far as the practitioners of the subject are concerned. Secondly, from these postulates the subject should come up with testable and disprovable deductions, that do not depend on who makes them. Finally, there should be tests for deciding whether a particular deduction is validated or disproved.

Astrology, when subjected to these conditions, has always been found to be wanting. The basic tenets of the subject show considerable variation, such as the way a horoscope is to be cast. Even with a given horoscope two astrologers may differ in their interpretation or prediction. Finally, often the predictions are vague and not disprovable.

Nevertheless, in the West, tests have been conducted of astrological predictions, to the extent that they can be tied down to definitive statements. We mention two examples which will illustrate how one may proceed. The first relates to the belief (common in India) that unless the horoscopes of an eligible boy and girl match astrologically, they should not marry.

Bernie Silverman, a graduate student from the Michigan State University, USA, had the following experiment as part of his Ph D thesis (received in 1971). His study picked out (A) 2978 couples who were happily married and (B) 478 couples who were divorced or separated. Their horoscopes were cast and given to two astrologers who were asked to agree between themselves as to whether the horoscopes belonging to a couple matched or not. The astrologers were not told to what class (A or B) each pair belonged. Accordingly, they made the classification using the astrological criteria they mutually agreed upon. Their classification was then compared with reality by applying statistical tests. These tests showed that there was no significant overlap between the two classifications. Thus astrological compatibility of horoscopes did not correspond to compatibility in real life. Details of this study have been published elsewhere[1,2].

A double-blind approach was used in our second example of a test of astrology. Carlson[3] used birth charts to test the astrological claim that the positions of the 'planets' (as assumed in astrology) at the moment of birth can be used to determine the subject's general personality traits and tendancies in temperament and behaviour, and to indicate the major issues the subject is likely to encounter. In this test astrologers were invited to make such interpretations for the birth charts of all the persons chosen for the study. Each person was given three such interpretations: the first being based on his/her real birth chart and two others chosen at random from this collection. The person was asked to rank them with marks out of ten depending on how accurate they were regarding their own self-assessment. A variation in this technique using California Personality Inventory (CPI) for the person was used instead in a second associated test. Here, the participating astrologers were each given a birth chart and three CPIs. One CPI corresponded to the birth chart given, while two others were randomly drawn from the sample. The astrologers were asked to rank the three CPIs according to how well they described the person with that birth chart.

If there is no correlation between the birth chart and personality, then, in the first experiment, one-third of the actual interpretations should be chosen as number 1. The astrologers claimed that if they are right at least half the actual interpretations should be correct. The experimenters allowed a 2.5σ variation above the chance expectation: anything higher would support the astrological hypothesis. A double-blind procedure was used so that neither the participant nor the experimenter knew what they were looking at. All details of birth charts vis-à-vis the persons they corresponded to were coded. Details are given in the paper referred to above. We simply state that in the first analysis the correct interpretation was obtained with a

probability of 0.337 and with an error 0.052, very close to the chance value of 1/3.

With this background we now come to our experiment.

The Pune experiment

While designing a suitable test we were conscious of the need that the outcome has to be beyond any ambiguity of interpretation. Thus in the Carlson experiment one could say that reading a person's personality may not be clear-cut. Indeed, as it was discovered in the course of the Carlson experiment, the CPI may not be recognized by the person to whom it belonged. The Silverman method of marriage compatibility is better, except that in the Indian context the rate of broken marriages is still rather low and collecting a large enough sample may pose difficulties. We will return to this point at the end of this paper.

For our experiments we chose a different but clear criterion, namely whether a person is intellectually bright or mentally handicapped. Astrologers claim to be able to tell this difference from the person's horoscope. So from amongst school children we collected a sample of 200 cases, with 100 each belonging to the above two classes. The intellectually bright children constituting group A were known from their school records as certified by their teachers. The mentally retarded children making up group B came from special schools for such children. Certified information from the parents about the birth details of their wards, necessary for casting their horoscopes was obtained. This field work was done by the volunteers of the Andhashraddha Nirmulan Samiti, Satara.

The next job was to cast their horoscopes. This was done using standard software by one of us (PG) who possessed enough experience in astrology, having been a practising astrologer a few years back.

The data were then codified with a code number assigned to each case. By deciphering the code number the concerned case could be fully identified; otherwise it remained an unknown entity. This was therefore a double-blind procedure since neither the experimenter nor the participant of the experiment could identify the case from the code number only. The data thus obtained and codified were stored in safe custody with the Statistics Department, Pune University.

Meanwhile, through public announcements and a press conference in Pune on 12 May 2008, practising astrologers were invited to participate in the experiment, the procedure for which was also explained. Of the 200 cases in our sample, each participant would be given a randomly drawn set of 40 birth charts along with the birth records. The participants had then a stipulated time limit by which they would have to identify each case as belonging to group (A) or (B), and send us their conclusions. For the initial set, the participants were asked to send a stamped registered envelope. Additionally, we also invited established astrological organizations to participate as institutions. In such cases we offered to make the entire sample of 200 cases available.

The nature of the statistical test is simple. We have two hypotheses to compare. The chance hypothesis H_0 is that the selection between groups A and B is like tossing a coin with probability 0.5 attached to each mode. The alternative hypothesis H_1 is that the classification using astrological prediction has success probability more than 0.5. For such a testing hypothesis problem, in order to reject H_0 in favour of H_1, the success rate has to exceed the mean expectation on the basis of H_0 by an amount equivalent to 2.32σ. This procedure ensures that the probability of wrongly rejecting H_0 is not more than 1%. For a binomial distribution with success probability $P = 0.5$, the mean for a sample size N is $0.5N$ and $\sigma = (N/4)^{1/2}$. For a sample size $N = 40$, we get the mean as 20 and $\sigma = 3.16$; so $2.32\sigma = 7.3$. In short, for our typical sample size the success rate of the astrologers to reject H_0 had to be at least 28. In the institutional case, the corresponding figures were mean = 100 and the required success rate for H_1 to hold was 117 or more.

Response of the astrologers

When this framework was announced, the response of the astrologers was varied. Some agreed to take up the challenge, others asked for additional conditions which had no relevance to the nature of the test being conducted, while some called upon the astrological community to boycott the test. We met several astrologers individually and also participated in a seminar where we explained the nature of the test, its objective and the precautions we were taking to prevent any rigging. We also pointed out that if the astrologers wished to claim that their subject was a science, then they need to face such tests. While on the whole the response was positive, some leading astrologers distanced themselves from the test.

In the end, 51 astrologers sent stamped envelopes as asked for and the sets were sent to them. Only 27 replied, sending their answers. These were then examined in the light of the data. The best performance was 24 out of 40, achieved by one astrologer only and this fell below the stipulated minimum for H_0 to be rejected in favour of H_1. The overall average success per sample for all 27 participants was 17.25, less than but consistent with the average of 20 predicted by H_0. So far as institutional participation was concerned, two organizations had agreed to participate. Eventually only one responded with answers. Its success rate was 102 out of 200, again well below the stipulated minimum of 117.

Thus we find on the basis of this test that the predictions given by the astrologers did not fare better than pure chance toss of a coin.

Concluding remarks

We feel that our test asked a well-focused question and the astrologers could not point to any ambiguity of interpretation. Many astrologers looked upon the success they had achieved (even though at a rate less than 50% expected by tossing a coin) as a testimonial to their predictive ability. We had to explain to them that real predictive success could be claimed only at 70% level for their sample size.

The test clearly demonstrated the hollowness of the basic claim of astrology as stated earlier. Diehard believers, of course, would not change their mind. However, it would be worthwhile conducting a similar double-blind test to check other aspects of astrological predictions. One important aspect has been the one tested by Silverman. Since a large fraction of marriages is arranged (or forbidden) on the basis of matching of horoscopes, a statistical study of this aspect will be useful. There may be several difficulties in gathering these data, but the effort would be well worth it.

1. Silverman, B., *J. Psychol.*, 1971, **77**, 141–149.
2. Silverman, B., *J. Psychol.* 1974, **87**, 89–95.
3. Carlson, S., *Nature*, 1985, **318**, 419–425.

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The global importance of patents

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Adam Smith, the 18th century English economist in his book, *An Inquiry into the Nature and Causes of the Wealth of Nations*, expounded that the wealth of a nation depends on capital, labour, and mineral resources[1]. Therefore, it is rather recent that the world has begun to view a nation's true wealth as being based on the creativity of its people and the ideas and innovations they generate, rather than on natural resources or access to low-skilled labour. Erich Bloch, former head of the US National Science Foundation[2], said in 1990:

> In the modern market place, knowledge is the critical asset. It is as important a commodity as the access to natural resources or to a low-skilled labor market was in the past. Knowledge has given birth to vast new industries, particularly those based on computers, semiconductors, biotechnology and designed materials.

Since the industrial revolution that began in Britain and spanned from the late 18th to the early 19th century, the world has undergone a tumultuous transformation[3]:

> The Western industrial technology has transformed the world more than any leader, religion, revolution or war. Nowadays, only a handful of people in the most remote corners of the earth survive with their lives unaltered by industrial products. The conquest of the non-Western world by the Western industrial technology still proceeds unabated.

Today, trillions of dollars, millions of jobs, and economic and geo-political power flow from the exploitation of technologies (such as biotechnology, electronics, communications, etc.) which have deep roots in science, rather than from raw materials and smoky factories.

William Bernstein, in his book *The Birth of Plenty*[4], cites four prerequisites for prosperity: (1) property rights (where advances are not confiscated by the government); (2) scientific rationalism (where, for example, religious beliefs do not overturn scientific advances); (3) capital markets (with some honesty) and (4) efficient communication and transportation (so one can sell what one produces at different places). The industrial revolution in England in the 1800s put these four prerequsites together with great effect. Today all developed and developing countries satisfy Bernstein's criteria and hence competition in the global market has intensified.

Patents create property from information

The essence of property right is the right of exclusion – to prevent trespassing. Patents create property from information. A patent is an alienable right of monopoly for a limited period, a tradable commodity of the most flexible sort. Trade in high-technology goods and services which are knowledge-intensive, and where intellectual property protection is most common, is among the fastest growing in international trade.

Since the 15th century, grants of ownership of intellectual property (IP) as a legitimate means of social and economic progress have grown enormously. In fact, Venice in 1594 granted Galileo, a 'privilege' (what we know as a patent) on a machine which he had invented[5] 'for raising water and irrigating land with small expense and great convenience', on the condition that it had never before been thought of or made by others. In his petition for the privilege he said, 'it not being fit that this invention, which is my own, discovered by me with great labor and expense, be made the common property of everyone'; and also, that if he were granted the privilege, 'I shall the more attentively apply myself to new inventions for universal benefit.'

Clearly, even Galileo, the father of modern science, was unwilling to divulge his invention for free exploitation by others. The Venetian Council saw merit in his argument and granted him a 'privilege' for 21 years.

The rising prosperity of England in the 19th century and the phenomenal prosperity of the US in the 20th century are outstanding examples of what limited-period ownership of IP granted and protected by governments can do. It is doubtful that without patent protection, epoch-defining technological innovations built around inventions such as the electric dynamo, the combustion engine and the transistor would have occurred as quickly. It is equally doubtful that chemical, pharmaceutical and electrical engineering industries would have flourished, or that the world would have seen the rise of corporations. It is the rise of corporations that led to the rapid expansion of the middle class.

University–industry and R&D laboratory–industry collaborations

Since the past several decades, the main drivers of advanced economies have been technology and technological innovations,